

DRAFT: Delta ISB List of Stressors

January 10, 2011

Note: This version incorporates comments received as of January 10, 2011, from Delta ISB members and those invited to participate in the Delta ISB Stressors Workshop.

The Table below is a list of stressors derived from documents such as BDCP, the POD synthesis, and others. It attempts to include all likely stressors (human influenced factors that impact the Delta ecosystem, water supply reliability, and the culture and economy of the Delta). It has lots of redundancy in the sense that many stressors are a consequence of other stressors. However, I have not tried to weed out any redundancy preferring at this stage to aim for inclusiveness. The notes are intended only to suggest some way(s) that the stressor affects the Delta and is not intended as an analysis of stressor effects. The columns Water, Land, Water Supply, Delta Place are used to indicate where the major impacts of the stressor fall. A more careful and organized analysis of where major impacts fall is needed as at the moment this is largely my subjective judgment. The list needs better organization into some logical groupings or categories but I have not had time to make such an organization. A number of people commented on a draft of the Table and I have tried to incorporate their comments.

Stressor	Notes	Water	Land	Water Supply	Delta Place
Habitat Loss	Almost all seasonal and tidal wetlands gone. Also gallery forests, native grasslands and many other habitats are greatly reduced or changed.	X	X	X	
Habitat Alteration	The Delta has changed from a mix of seasonal and perennial wetlands, and riparian habitats with many dead-end channels to a simplified system of leveed agricultural islands separated by deep interconnected channels with leveed shorelines.	X	X	X	X
Habitat Fragmentation	Natural habitats reduced to small, often unconnected fragments.	X	X		X
More Habitat Uniformity	Delta channels dredged, simplified, interconnected. Agriculture has simplified terrestrial diversity.	X	X	X	X
Less Habitat Connectivity	Channels no longer connected to floodplain. Uplands less connected to Delta.	X	X		X
Reduced Inflow	Upstream withdrawals. Possibly lower water yield with climate change.	X		X	
Reduced Outflow	Water project and in-Delta				

Stressor	Notes	Water	Land	Water Supply	Delta Place
	withdrawals reduce flow through the Delta.	X		X	
Changed Hydrograph	Reduced seasonal flow variation. Earlier, smaller freshet with climate change. Improved seasonal availability of water for agriculture.	X	X	X	
Entrainment at Pumps	Effect of OMR Flows on fish movement and water supply.	X		X	X
Entrainment at Other Sites	In-Delta withdrawals for agriculture and domestic water, power plants.	X		X	X
Changed Water Residence	Simplification and interconnection of Delta channels has made residence time more uniform. Improved water conveyance to south Delta.	X	X	X	
Changed Flow Pattern	Interconnection and simplification of channels has changed flow velocity and pattern. Entrainment of salt affects domestic water supply.	X	X	X	X
Migration Barriers	Low DO and thermal barriers occur under altered hydrograph, changed channel morphology, sewage.	X			
Altered Migration Corridors	Reverse flow in S Delta can affect fish migration.	X		X	
Access to Breeding Sites	Loss of floodplain and infrequent floodplain inundation affects floodplain spawners like Splittail. Upstream dams cut anadromous species off from historic spawning habitat.	X	X		
More Nitrate	Fertilization of the Delta by agriculture and domestic waste affects water quality.	X	X		
More Ammonium	Elevated ammonium can reduce phytoplankton production and poison other organisms.	X			
Less Phosphorus	Changed N/P ratios have many effects throughout the food chain and often favor invasive species.	X			
Methyl Mercury Release	Changing Delta conditions can affect the methylation of mercury trapped in sediments.	X	X		X
Selenium Release	Selenium released in agriculture and by industry can be toxic especially through the food chain.	X	X		
Other Trace Metals	Toxic heavy metals such as lead,				

Stressor	Notes	Water	Land	Water Supply	Delta Place
	chromium, copper, are introduced from agriculture, industry, domestic waste and storm water.	X	X		
Pesticide Release	Pesticides are released by agriculture, industry and domestic use (currently of concern are pyrethroids and organophosphates but see also 303d list for Suisun Bay and Delta Waterways).	X	X		
Other Toxic Chemicals (e.g. see 303d list for Suisun Bay and Delta Waterways).	Many toxic chemicals (organic and inorganic) are released into the Delta (e.g., surfactants, endocrine mimics and disruptors).	X	X	X	X
Bioconcentration	Some organisms absorb toxic substances in higher concentration than found in the surrounding environment.	X	X	X	
Bioaccumulation	Toxic substances can be concentrated as they move up the food chain.	X	X		X
Higher Temperature	Temperature of the Delta environment is increasing due to global warming. All organisms will be affected by higher temperatures.	X	X	X	X
Seasonal Temperatures	Seasonal temperature variation has been affected by changing hydrology of the Delta and will be affected further by global warming.	X	X		X
Higher Salinity	Average salinity of the Delta has increased due to reduced inflows and increased channel size, and will increase further as sea level rises.	X		X	X
Salt Penetration	The enlarged and interconnected channel system of the Delta allows greater tidal excursion and salt penetration into the Delta.	X		X	X
Sea Level Rise	With global warming sea level is rising imposing many risks on the Delta.	X	X	X	X
Subsidence in Delta Islands	Loss of peat soils in Delta islands is resulting in subsidence increasing the risk to structures and habitat	X	X	X	X

Stressor	Notes	Water	Land	Water Supply	Delta Place
	change if levees breach.				
Changing Sediment Load	Sediment discharge into and through the Delta increased dramatically with European colonization but is now declining.	X	X	X	X
Changing Erosion/Deposition	Falling sediment discharge into and through the Delta in recent years together with rising sea levels is affecting rates of erosion.	X	X		X
Declining Turbidity	Affects phytoplankton and SAV growth, smelt distribution, and other aspects of Delta ecology.	X		X	X
Dredging	Dredging of channels mobilizes sediment and toxins, impacts benthic organisms.	X		X	X
Local Low DO	A number of factors lead to low DO in some estuary channels.	X		X	
Stranding	Rapid dewatering of floodplains due to water management actions can strand fish and other aquatic organisms.	X	X		
Changed Prey Types	Invasion of exotic organisms affects the types of food organisms available for species of concern (like Delta smelt).	X	X		
Low Prey Numbers	Heavy competition from invasive species (like the Asian clams) and changing water chemistry can significantly reduce the food supply for native species.	X	X?		
Higher Predation	Increased predation by non-native predators such as largemouth bass, striped bass, red fox, can affect the viability of native species.	X	X		X
Food Web Changes	Impact of species like <i>Corbula</i> and changed nutrient regimes shifting energy flow to benthic and microbial rather than pelagic pathway.	X	X		
SAV Expansion	Changing sedimentation patterns, flow patterns, cover for predators nutrient cycling.	X			
Legal Harvest	Incidental take of threatened species, demand for artificial propagation.	X	X		X

Stressor	Notes	Water	Land	Water Supply	Delta Place
Illegal Harvest	Illegal take of threatened species can affect population viability.	X	X		X
Changing Competition	Habitat change, fragmentation, species invasion, can affect competition among species, changing community structure and disadvantaging native species.	X	X		X
Changing Phenology	Global warming affects the seasonal rhythms of species in different ways, leading to such things as timing mismatch between predators and prey, flower and pollinator, etc.	X	X		X
Changed Community Structure	Substantial changes in phytoplankton and zooplankton; Tule, native forest and grassland replaced by agriculture.	X	X		X
Low Abundance	Species driven to low abundance by one or another stressor may be unable to recover due to Allee effects or other factors.	X	X		
Hatchery Impacts	Hatchery culture is believed to alter the genetic make-up of cultured species affecting their ability to perform well in the wild and potentially also affecting wild conspecifics with which they breed.	X	X		X
Species Invasion	Affects the structure of food webs often to the detriment of native species. Sometimes pests of agriculture.	X	X		X
Microcystis Blooms	Toxic species that can affect fish populations locally.	X		X	X
Disease	Habitat alteration, changing climate, species invasion can all affect the occurrence and impact of disease.	X	X	X	X
Changing Ocean	Many Delta species spend part of their lives living or feeding in the ocean, which is changing with global warming.	X	X		
Earthquake	Bay Area faults are likely to produce large earthquakes in coming decades that may damage the Delta's levees and highways.	X	X	X	X

Stressor	Notes	Water	Land	Water Supply	Delta Place
Artificial Levees	Levees have isolated land and water ecosystems, and made possible the development of the unique cultural and economic character of the Delta.	X	X	X	X
Levee Breaks	Permanent flooding of multiple western islands would likely raise salinity in the southern Delta. Native fish may not use deeply flooded islands.	X	X	X	X
Landscape Change	The habitat mosaic of the Delta is constantly changing as human land and water use evolves.	X	X		X
Urban Expansion	Affects the Delta environment and habitats in many ways that threaten native species and ecosystems as well as to water quality and demand and unique attributes of the Delta.	X	X	X	X
Upstream land use	Affects the quantity and quality of water entering the Delta, sediment load, habitat for species that migrate through the Delta.	X		X	
Upstream Dams	Upstream dams affect virtually every aspect of the Delta environment, society and economy.	X	X	X	X
California Economy	Patterns of development, agriculture, recreation are driven by economics.	X	X	X	X
Lifestyle Choices	Decisions about where to live and how to live affect species and habitats.	X	X		X
Urban – Rural migration patterns	Dominant migration patterns are rural -> urban; inland -> coastal		X		X
Federal/State Agricultural Policy	Ag subsidies greatly -affect land use and habitation patterns	X	X		X
Development Zoning, Building Codes, etc.	Effect land use, lifestyle choices and many other human decisions affecting the Delta.	X	X	X	X
Population Growth	Places increasing pressure on land and water resources.	X	X	X	X